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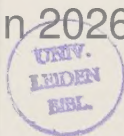
INCIDENCE OF TIBIO-FIBULAR SHAFT AND ANKLE FRACTURES IN CHILDREN

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ABSTRACT

The incidence of tibio-fibular shaft and ankle fractures in children aged 0-18 years was calculated in the area primarily served by the University Hospital in Lund. Out of 919 fractures treated during the period 1971-1979, 746 fractures occurred in the chosen population.

The accumulated incidence 0-18 years of age of tibio-fibular shaft fractures was 190 and 110 per 10.000 boys and girls, respectively, whereas the accumulated incidence of ankle fractures was slightly less (172) in boys, but higher (141) in girls. The accumulated incidence of physeal fractures of distal tibia and/or fibula was 118 in boys and 90 in girls including tibio-fibular shaft fractures associated with ankle fractures. The accumulated incidence of ankle fractures without growth plate fracture in children with open growth plates was 13 in boys and 19 in girls.

Longitudinal tibio-fibular shaft fractures occurred at the same age in boys and girls, whereas transverse fractures occurred at a higher age in boys mainly due to traffic accidents and sport.

Ankle fractures occurred at a higher age than tibio-fibular shaft fractures. Injuries classified as supination-eversion and supination-adduction were found to be the most common types, but supination-eversion injuries occurred at a higher age than supination-adduction injuries.

The traumatological classification by Gerner-Smidt was compared with the anatomical classification by Salter and Harris. The traumatological classification failed to classify 14 cases (5%), whereas 48 (17%) of the physeal fractures could not be classified according to Salter and Harris. Of these, 33 showed combinations of physeal fractures, nine showed zig-zag pattern, and six were undeterminable.

The results of the study suggest that rotational trauma to the lower leg results in a longitudinal fracture of the tibio-fibular shaft in the younger child and in an ankle fracture in the older child. No corresponding

relation between transverse tibio-fibular shaft fractures and ankle fractures due to bending could be found.

INTRODUCTION

Epidemiological data are important in investigating the aetiology of different fracture types (26). They constitute a basis for prevention of fractures (4, 30). Earlier studies of tibio-fibular shaft and ankle fractures have concerned the relative frequencies (2, 16, 39), annual incidence of all types of lower limb fractures (15), excluded children (30), or excluded some fracture types (6). No investigations of the annual incidence of tibio-fibular shaft and ankle fractures during childhood and adolescence were made.

It was earlier suggested (24) and experimentally demonstrated (16) that the same trauma during childhood results in a longitudinal fracture of the tibial shaft and during the adolescence in an ankle fracture.

Earlier studies concerning the age distribution of different ankle fractures were based on a different classification (2, 8, 36); this made comparison difficult. Gerner-Smidt in 1963 (16) introduced a traumatological classification of ankle fractures in children based on the terminology used by Lauge-Hansen (24). The traumatological classification by Gerner-Smidt (16) was tested by Kärrholm et al. (21, 22, 23).

This study evaluated the incidence of different fracture types from a defined population. Furthermore, Gerner-Smidt's traumatological classification (16) was compared with the Salter-Harris classification (34).

MATERIALS AND METHODS

Children and adolescents aged 0-18 years with tibio-fibular shaft or ankle fractures treated as out- and/or inpatients at the Department of Orthopaedic Surgery, University Hospital, in Lund, during the years 1971-1979, were traced using the diagnosis code register (11). The radiograms were reevaluated and data from the case records about age, sex, date of injury, mechanism of injury, and treatment were collected.

Incidence calculation

Patients living in the primary area of the University Hospital in Lund were identified in order to calculate the annual and accumulated incidence of different fracture types. The city of Lund is situated in an agricultural district and the total population in the primary area of the University Hospital is about 200,000. Information about the population in separate age groups from age 0-18 years was available from 1973-1979. The total population of all age groups varied between 25,836 and 28,105 boys and between 24,403 and 26,592 girls. The size of the population aged 0-18 years during 1971 and 1972 was presumed to be the same as in 1973.

Classification of the material

- I. Tibio-fibular shaft fractures (a and b) were classified according to Bauer et al. (3), Edwards (9), and Önnerfält (40).
 - a. Transverse fractures
 - b. Longitudinal fractures
 - c. Comminuted, atypical or unknown fracture anatomy
 - d. Tibio-fibular shaft fracture combined with ankle fracture
- II. Ankle fractures with open growth plates were traumatologically classified according to Gerner-Smidt (16) and Kärrholm et al. (21, 22, 23) and anatomically according to Salter and Harris (34).
 - a. Supination-eversion
 - b. Supination-adduction
 - c. Supination-inversion
 - d. Adduction-compression

- e. Pronation-eversion
 - f. Pronation-abduction
 - g. Pronation-dorsal flexion (25)
 - h. Atypical fractures
- III. Ankle fractures with closed growth plates were classified according to Lauge-Hansen (24).

Statistical analysis

Difference in average age of injuries in boys and girls were calculated using Student's t-test. Comparison of the number of cases with different injuries was performed using Chi-square analysis. The relative risk (RR) of various fracture types was calculated using a modification of the Mantel-Haenszel test according to Miettinen (27, 28).

RESULTS

The results are given from the material consisting of patients living in the primary area of the University Hospital in Lund (regional material). The total number of fractures (total material) is given in the text and in the tables.

436 boys (total material 537) and 298 girls (366) had 442 (547) and 304 (372) fractures, respectively. Three girls and one boy showed bilateral tibio-fibular shaft fractures; of the remaining injuries, 318 (43 %) were left sided and 420 right sided. Eight-teen (total material 27) tibio-fibular shaft fractures were open but no ankle fracture (total material 1).

Tibio-fibular shaft fractures (Tables 1-1 and 2, Figs. 1-1 and 1-2)

The incidence of tibio-fibular shaft fractures in boys showed a maximum at 3-4 and 15-16 years of age. The first maximum was mainly due to longitudinal fractures; the second to transverse. In girls, the incidence was more even up to 11-12 years of age, but with a tendency to lower values

Table 1-1. Number of cases, average age, and accumulated incidence of different types of tibio-fibular shaft fractures in the regional material. Number of cases in the total material in parentheses.

Type of fracture	Sex	No of cases (legs)	Mean age $\pm$ SD	Accumulated incidence per 10,000 boys/girls 0-18 years of age
Longitudinal				
Tibia	Male	78 (92)	6.1 ± 3.9	57.6
	Female	58 (64)	6.1 ± 3.1	44.8
Tibia and Fibula	Male	16 (18)	11.5 ± 4.2	13.1
	Female	8 (10)	10.9 ± 2.6	6.6
	Male	94 (110)	7.0 ± 4.4	70.7
	Female	66 (74)	6.6 ± 3.4	51.4
Transverse				
Tibia	Male	66 (72)	9.1 ± 5.2	55.8
	Female	33 (38)	6.1 ± 4.8	26.1
Fibula	Male	6 (8)	13.0 ± 2.6	5.3
	Female	1 (3)	1.0	0.8
Tibia and Fibula	Male	68 (94)	10.5 ± 5.2	51.9
	Female	27 (33)	7.3 ± 6.1	22.2
	Male	140 (174)	10.0 ± 5.3	113.0
	Female	61 (74)	6.5 ± 5.4	49.1
Others				
Comminuted	Male	2 (5)	16.5 ± 0.7	1.9
	Female	5 (8)	8.0 ± 3.4	4.0
Double	Male	1 (2)	14.0	1.0
	Female			
Callus only	Male	- (2)		
	Female	- (-)		
Unknown or atypical	Male	- (1)		
	Female	3 (3)	3.3 ± 2.3	2.3
Associated with ankle fracture	Male	4 (4)	14.8 ± 0.5	3.6
	Female	4 (5)	10.5 ± 2.1	3.2
	Male	7 (14)	15.1 ± 1.1	6.5
	Female	12 (16)	7.7 ± 3.8	9.5
	Male	241 (298)	9.0 ± 5.3	190.2
	Female	129 (164)	6.7 ± 4.4	118.0

with increasing age. The average age of transverse fractures in boys was 3-4 years more than in girls ($p < 0.001$), consistent with the increase in incidence of transverse tibio-fibular fractures in boys after 12 years of age. No difference was observed between boys and girls with longitudinal fractures.

The relative risk of tibio-fibular shaft fracture was higher in boys ($p < 0.001$) mainly due to a higher risk for transverse fractures in the upper age groups (Table 2).

Fracture type	Age group	girls/boys			
		RR	95% confidence interval	χ^2	
Tibio-fibular shaft					
Transverse	0-7	0.76	0.50 - 1.17	1.53	N.S.
	0-18	0.46	0.34 - 0.61	27.58	***
Longitudinal	0-18	0.74	0.54 - 1.02	3.40	N.S.
	0-7	0.85	0.64 - 1.13	1.26	N.S.
	0-18	0.61	0.49 - 0.75	22.44	***
Ankle, open growth plates					
Supination-eversion	0-18	1.01	0.70 - 1.45	3.46	N.S.
Supination-adduction	0-18	0.92	0.63 - 1.35	0.16	N.S.
	0-7	1.97	1.04 - 3.72	4.34	*
	0-18	0.89	0.71 - 1.12	0.98	N.S.
Ankle, open and closed growth plates					
	0-18	0.87	0.71 - 1.07	1.82	N.S.

Table 2. Relative risk (RR) with 95% confidence interval and its Chi-square (χ^2) with significance for various fracture type. Comparison of girls v. boys 0-18 years of age.

*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$; N.S. $p > 0.05$

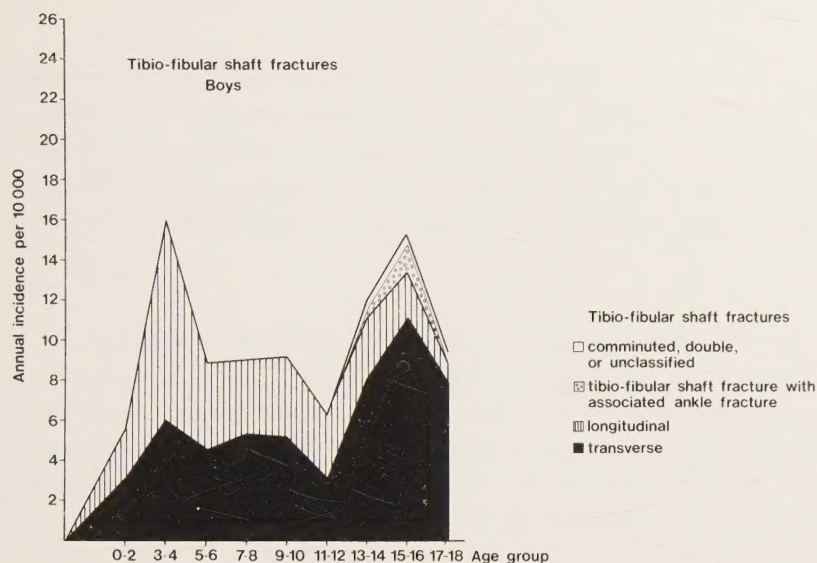


Fig. 1-1 Annual incidence of tibio-fibular shaft fractures in boys.

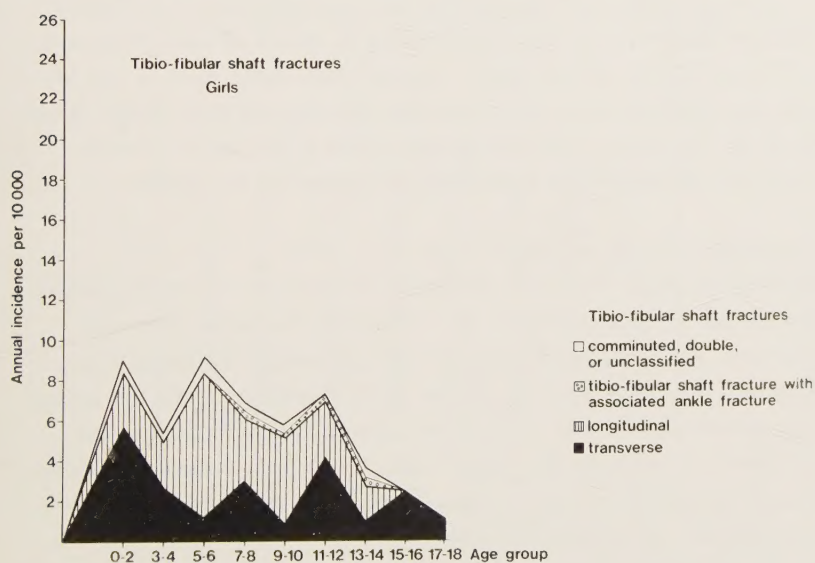


Fig. 1-2 Annual incidence of tibio-fibular shaft fractures in girls.

Combined transverse fractures of the tibio-fibular shaft were more common than combined longitudinal fractures in both boys and girls ($p < 0.001$), and combined longitudinal fractures occurred at a higher average age in both boys and girls ($p < 0.001$), whereas isolated transverse tibial fractures occurred at about the same average age as did combined in both boys and girls.

Comminuted fractures were observed in seven cases, double fractures in one; in three, the fractures were registered only from the case records. In the total material, an additional ten cases were found; of these two were present only as a callus formation earlier described by Tachdjian (38) as a sign of diaphyseal fracture in the infant. Both cases observed in this study were less than one year of age.

Three cases showed a diaphyseal fracture continuing down to the distal tibial growth plate. Another three showed a diaphyseal fracture and a separate physeal-epiphyseal fracture of the distal tibia; in all three, as a fracture separation of the antero-lateral corner of the tibial epiphysis (Tillaux type). Tibial shaft fracture continuing down to the ankle joint was found in two cases; one case with open and one with closed growth plates. The total material included also a girl with a tibial shaft fracture and a comminute fracture of the medial malleolus.

Ankle fractures (Tables 1-2 and 2, Figs. 1-3, 1-4)

The incidence of ankle fractures increased in girls up to 11-12 years of age; in boys up to 13-14 years of age concerning fractures with open growth plates, and up to 15-16 years of age including fractures with closed plates. The relative risk for an ankle fracture in all age groups with open growth plates, and with closed growth plates included, was about the same for boys as for girls (Table 2, p. 7). However, in fractures occurring before 8 years of age, there was a tendency to a higher relative risk for girls ($p < 0.05$) consistent with the finding that the average age for ankle fractures was 1-2 years more for boys than for girls in cases with open growth plates ($p < 0.001$); also when cases with closed growth plates were included ($p < 0.001$).

Table 1-2. Number of cases, average age and accumulated incidence of different type of ankle fractures in the regional material. Number of cases in the total material in parentheses.

Type of fracture	Sex	No of cases (legs)	Mean age ± SD	Accumulated inci- dence per 10,000 boys/girls 0-18 years of age
OPEN GROWTH PLATES				
Supination-eversion	M	63	(76)	± 2.6
	F	56	(70)	13.0 ± 2.3
Supination-adduction	M	49	(68)	± 3.6
	F	50	(60)	10.5 ± 3.1
Supination-inversion	M	5	(5)	± 1.8
	F	10	(10)	11.6 ± 2.4
Adduction-compression	M	3	(4)	± 3.5
	F	1	(1)	7.0 ± 3.0
Pronation-eversion	M	11	(20)	± 3.4
	F	3	(3)	13.0 ± 1.0
Pronation-abduction	M	11	(12)	± 2.3
	F	4	(13)	13.0 ± 2.4
Pronation-dorsal flexion	M	2	(3)	± 2.1
	F	1	(1)	12.5 ± 3.0
Atypical	M	10	(10)	± 2.0
	F	4	(7)	13.6 ± 5.1
CLOSED GROWTH PLATES				
	M	154	(198)	± 3.2
	F	129	(165)	12.1 ± 3.2
	M	47	(51)	± 0.8
	F	36	(43)	16.4 ± 1.6
	M	201	(249)	± 3.4
	F	165	(208)	13.1 ± 3.7
				172.4
				141.2

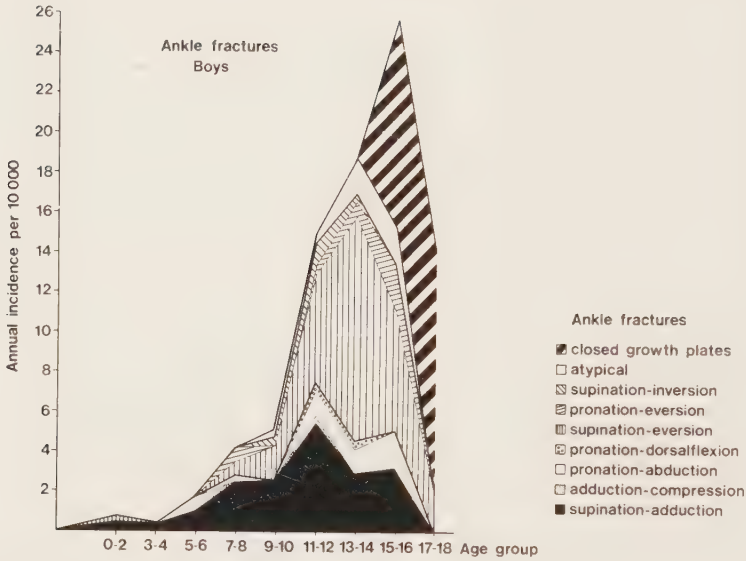


Fig. 1-3 Annual incidence of ankle fractures in boys.

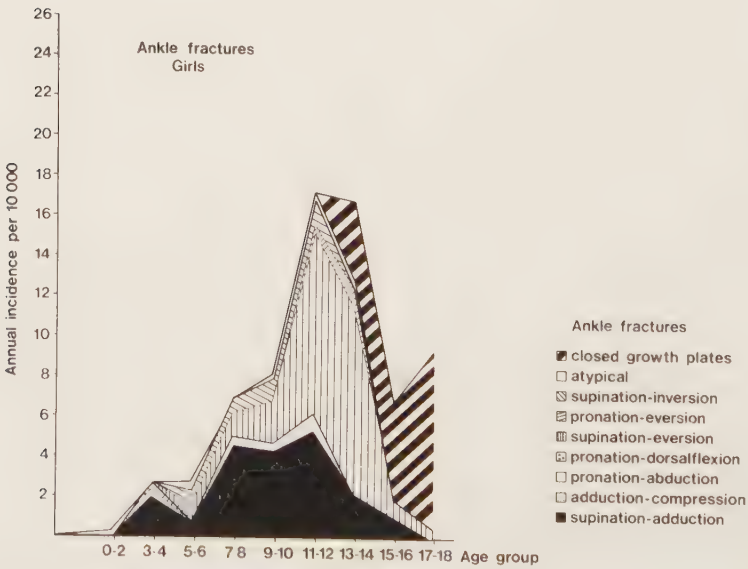


Fig. 1-4 Annual incidence of ankle fractures in girls.

Injuries classified as supination-eversion and supination-adduction were found to be the most common; the difference between these types was insignificant. However, supination-adduction injuries occurred at a lower average age than supination-eversion injuries (boys $p < 0.001$, girls $p < 0.001$).

Ankle fractures occurred at a higher average age than tibio-fibular shaft fractures, also concerning cases with closed growth plates in both boys and girls (boys $p < 0.001$, girls $p < 0.001$).

Fractures of the growth plate of the distal tibia and/or fibula were found in 251 cases (136 distal tibia, 85 distal fibula, and 30 distal tibia and fibula), including seven cases with physeal fracture through distal tibia associated with diaphyseal tibial fracture (Table 3).

Table 3. Classification of physeal fractures in the total material according to Salter and Harris (34). Number of cases in the total material in parentheses.

		Number of fractures	
Salter-Harris		Tibia	Fibula
Salter-Harris classification applicable	I	7 (10)	69 (84)
	II	76 (102)	27 (29)
	III	37 (52)	14 (17)
	IV	3 (3)	
Totals		123 (167)	110 (130)
Salter-Harris classification not applicable	I+II	1 (1)	
	II+III+IV, III+IV	32 (36)	
	Z	4 (6)	5 (5)
	undeterminable	6 (7)	
Totals		43 (50)	5 (5)
Totals, both groups		166 (217)	115 (135)

The accumulated incidence of isolated physeal fractures of the distal tibia (including cases with physeal fracture of distal tibia associated with dia-physeal fracture) was 63 and 53 per 10,000 boys and girls, respectively; of the distal fibula 41 and 27, of combined injuries 14 and 10.

Table 4. Mechanism of injury. Number of cases and average age in boys and girls with tibio-fibular shaft and ankle fractures.

Mechanism of injury	Sex	Tibio-fibular shaft fractures		Ankle fractures	
		No of cases	Mean age $\pm$ SD	No of cases	Mean age $\pm$ SD
Fall from standing position	Male	35 (38)	4.2 $\pm$ 3.1	28 (36)	13.1 $\pm$ 2.7
	Female	19 (20)	5.3 $\pm$ 4.1	23 (32)	11.9 $\pm$ 3.1
Fall from height	Male	24 (35)	4.4 $\pm$ 2.9	22 (28)	11.7 $\pm$ 3.9
	Female	18 (19)	2.7 $\pm$ 3.5	26 (37)	9.4 $\pm$ 2.9
Traffic accident	Male	73 (97)	11.9 $\pm$ 5.1	41 (58)	14.2 $\pm$ 2.8
	Female	30 (42)	8.5 $\pm$ 4.5	24 (31)	12.5 $\pm$ 3.9
Spoke injury	Male	9 (9)	3.0 $\pm$ 0.7	5 (7)	5.6 $\pm$ 2.2
	Female	16 (19)	3.8 $\pm$ 2.2	9 (9)	4.6 $\pm$ 1.7
Winter sports	Male	49 (59)	10.6 $\pm$ 3.5	17 (20)	13.5 $\pm$ 2.4
	Female	33 (35)	9.0 $\pm$ 2.7	11 (14)	10.5 $\pm$ 2.9
Ball games, athletics	Male	26 (29)	11.0 $\pm$ 5.3	44 (51)	13.8 $\pm$ 2.4
	Female	5 (5)	11.6 $\pm$ 1.1	30 (38)	12.8 $\pm$ 2.5
Fall from horse	Male	2 (2)	9.0 $\pm$ 5.7	1 (1)	17.0
	Female	4 (4)	12.5 $\pm$ 1.3	13 (14)	13.6 $\pm$ 3.3
Kicked, blow, or crush injury	Male	14 (18)	8.0 $\pm$ 4.6	9 (9)	13.7 $\pm$ 3.6
	Female	5 (6)	3.8 $\pm$ 3.0	2 (2)	11.5 $\pm$ 2.2
Twist undefined	Male	4 (4)	6.7 $\pm$ 1.9	21 (25)	12.0 $\pm$ 4.2
	Female	3 (3)	2.7 $\pm$ 2.1	21 (22)	13.0 $\pm$ 3.0
Skateboard, roller skating	Male	1 (1)	15.0	7 (7)	14.4 $\pm$ 1.5
	Female	- (1)		3 (3)	14.0 $\pm$ 3.6
Unknown	Male	4 (6)	9.5 $\pm$ 5.2	6 (7)	11.3 $\pm$ 5.5
	Female	6 (10)	5.3 $\pm$ 5.1	3 (6)	12.7 $\pm$ 4.6
Male		241 (298)		201 (249)	
Female		139 (164)		165 (208)	

Mechanism of injury (Table 4)

Traffic accidents were the most common cause of injury (168 cases). However, girls suffered ankle fractures due to several other trauma mechanisms, and tibio-fibular shaft fractures at winter sports about as often as in traffic accidents. The average age of children suffering traffic accidents varied between 8-14 depending on sex and fracture type, tibio-fibular shaft fractures occurring at a lower average age than ankle fractures in both boys ($p < 0.01$) and girls ($p < 0.01$), and at a lower average age in girls than in boys, especially concerning tibio-fibular shaft fractures (tibio-fibular shaft fractures $p < 0.01$, ankle fractures $p < 0.05$). Most commonly, the injured boy had been riding a motorcycle (56 cases), a bicycle (27 cases), or when walking was struck by a vehicle (26 cases). Girls had most commonly been riding a bicycle (32 cases), were struck by a vehicle walking in eleven cases, or had been involved in a motorcycle accident in eight cases.

Fall to the ground from standing position or from a height resulted in a tibio-fibular shaft fracture in the younger children and in an ankle fracture in the older ones (boys $p < 0.001$, girls $p < 0.001$).

Spoke injuries occurred at a low average age in both boys and girls; resulting in a tibio-fibular shaft fracture at a lower average age than in an ankle fracture in boys ($p < 0.01$), but the difference of average age in girls was insignificant.

Tibio-fibular shaft fractures because of sporting activities occurred at a somewhat lower average age than ankle fractures in boys (winter sports $p < 0.05$, athletics and ball games $p < 0.01$), the difference in girls was insignificant. Winter sport was a common cause of tibio-fibular shaft fractures compared with athletics and ball games in both boys and girls, whereas ankle fractures were found to be more commonly caused by athletics or ball games than winter sports (boys $p < 0.001$, girls $p < 0.001$).

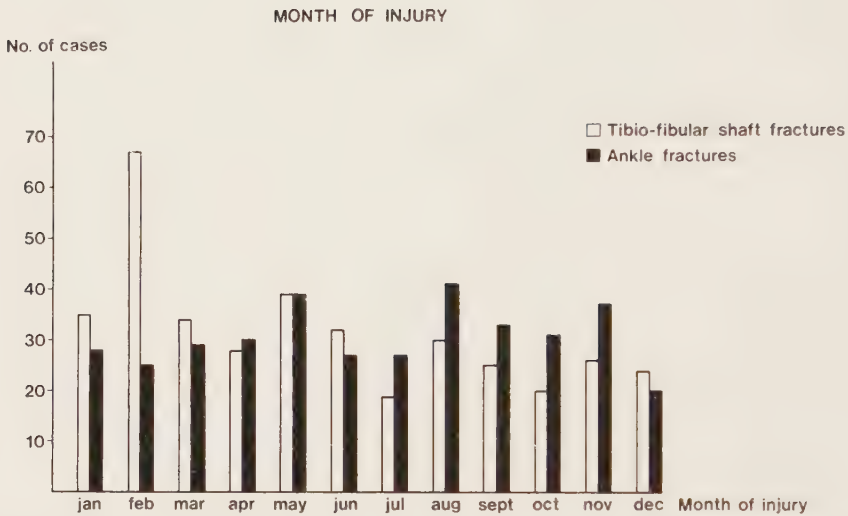


Fig. 2 Month of injury.

Months of injury

The fracture distribution is shown in Fig. 2.

Associated injuries and diseases

Thirty-six patients (27 with tibio-fibular shaft fractures, nine with ankle fractures) showed 38 associated injuries. In the total material, 72 associated injuries occurred in 51 patients (Table 5).

Ten children had a developmental disorder or a disease such as osteogenesis imperfecta, osteopetrosis, hydrocephalus, myelomeningocele, juvenile chronic arthritis, mental retardation, or epilepsy. The total material included another three cases: two with hemiparesis and one with myelomeningocele. Reduced bone strength could be suspected here in addition to trauma. Two boys in the regional material with ankle fractures had, one before and one after, suffered slipped capital femoral epiphysis, and one had had Perthes' disease.

Table 5. Associated injuries. Figures in parentheses refer to the total material

Type of injury	No. of injuries	
Injury of the head	10	(21)
Fracture of the femur	9	(22)
Injury of the upper extremity	5	(7)
Fracture of the clavicle	3	(3)
Fracture of the patella	3	(3)
Fracture of the pelvis	2	(5)
Fracture of the thorax	2	(2)
Fracture of the foot	1	(4)
Fracture of the tibial condyle	1	(1)
Ligamentous injuries of the knee	1	(1)
Sterno-clavicular dislocation	1	(1)
Fracture of the scapula	-	(1)
Major vascular injury	-	(1)
=====		
Total	38	(72)

DISCUSSION

This investigation has been performed in an area regulated by the Swedish medical care system indicating that almost all cases with fractures and joint injuries from the primary region are included in the material. This implies that the incidences found in this material are very close to the real incidences as very few cases are missed.

The frequency of tibial fractures during childhood is estimated at about 14-15% of all fractures (5, 17, 37). Feldkamp et al. (13) found 8% diaphyseal fractures indicating a small dominance of tibio-fibular shaft fractures, whereas Bartl (2), Ehalt (10), and Steinert and Bennek (37) found a more pronounced dominance of tibio-fibular shaft fractures. This study found the frequency of tibio-fibular shaft fractures and ankle fractures rather equal, but showed a variation between boys and girls indicat-

ing that tibio-fibular shaft fractures were somewhat more common than ankle fractures in boys, whereas ankle fractures were somewhat more common than tibio-fibular shaft fractures in girls ($p < 0.05$).

Lund corresponds to a flat part of southern Sweden, whereas other materials (10, 20) were collected from Austria and southern West Germany, respectively, with many skiing injuries. Moreover, in February many families in Lund and surrounding areas go abroad or to the northern part of Sweden on skiing holidays corresponding to the large frequency of tibio-fibular shaft fractures during this month found in the present material.

Some materials (10, 12) show an increasing number of tibio-fibular shaft fractures up to 15 or 18 years of age, whereas Buhr and Cooke (6) only registered this increase in boys but not in girls. The present material showed a decreasing frequency of longitudinal fractures in both boys and girls, whereas transverse fractures were more evenly distributed. However, the number of transverse fractures increased in boys 13-17 years of age mainly due to motorcycle and soccer accidents. Some reports (13, 37) have shown that isolated tibial fractures occur at a lower average age than fractures of both tibia and fibula, but here this difference was only significant concerning longitudinal fractures. This is probably due to a greater elasticity of the bone and of the tibio-fibular attachments in the younger child (13, 20, 33). Bartl (2) suggested that the older child would suffer a more violent trauma explaining the higher frequency of combined fractures of the tibio-fibular shaft in the older child. This study showed that the average age of isolated transverse tibial fractures and combined was about the same, rather indicating a variable resistance to bending and rotational trauma during different skeletal maturity. Furthermore, transverse fractures can be produced by bending of the bone and by a direct trauma. The different average ages of different trauma mechanisms producing tibio-fibular shaft fractures suggest that transverse fractures produced by a bending force are more common in the younger child, whereas a direct trauma as in traffic accidents occurs more commonly in the older child.

Internal bending and/or axial compression of the foot and the ankle (supination-adduction, adduction-compression) produces a specific fracture pattern of the ankle (16, 22) or a transverse metaphyseal tibio-fibular fracture above the growth plate. The bending force is most accentuated laterally resulting in a transverse metaphyseal fibular fracture followed by a tibial fracture. Transverse metaphyseal tibio-fibular fracture was found especially in the younger child who had stuck his foot in the wheel of the bicycle, and may partly explain the higher frequency of combined transverse fractures of the tibia and fibula during these ages.

The distribution of longitudinal tibio-fibular shaft fractures compared with ankle fractures of rotational type (supination-eversion, pronation-eversion, supination-inversion) suggests that rotational trauma to the lower leg results in a longitudinal tibial fracture in the young child and in an ankle fracture of rotational type in the older one (more than 9-10 years of age).

Tibio-fibular shaft fractures and ankle fractures occurred at a lower average age in girls than in boys due to different skeletal maturity. However, the adolescent boys are more likely to suffer a transverse tibio-fibular fracture as described above and mostly in traffic accidents partly explaining this difference. Transverse fractures were also more common than longitudinal in boys but not in girls. Some investigations (2, 8) showed that boys more commonly suffered an ankle fracture than girls. In this study the difference was insignificant. This might be because girls participate more actively in athletics and ball games than earlier. This is supported by the findings in this study that ankle fractures often occur during these activities.

Fractures because of spoke injuries occurred in 39 cases. Juhl (18) reported four fractures out of 57 spoke injuries, whereas Kølle-Jørgensen and Budtz-Olsen (19) reported 41 fractures out of 163 injuries indicating that spoke injuries with soft tissue lesions were four to ten times more common albeit there is a law in Sweden concerning the use of a pro-

tective device (35) when carrying a child sitting behind on a bicycle. However, such a device does not always give satisfactory protection (18) and is not always used.

Skateboard was introduced in Sweden 1977-1978 and the injuries found in this material represent mainly 1978-1979. One injury due to roller skating was included in this group.

Physeal fractures of distal tibia and/or fibula were found in 251 cases. Five (4%) of the fibular physeal fractures and 43 (26%) of the physeal fractures of distal tibia could not be classified according to the Salter-Harris classification. In summary, 17% (48 fractures) of the physeal fractures could not be classified according to Salter-Harris. The traumatological classification failed to classify 14 cases (5%) in this study, but in another study (16), only three out of 300 fractures failed to fit the traumatological classification. The accuracy of a classification is greater in a prospective study allowing a more detailed clinical and radiographical examination of hardly definable or atypical cases.

The accumulated annual incidence of physeal fractures of the distal tibia was compared with a material presented by Alffram and Bauer (1) concerning fracture displacement of the distal radial epiphysis. The accumulated incidence of this fracture type was found to be about the same as for isolated fractures of the distal tibia in boys, but only about half of the accumulated incidence in girls. Earlier investigations (10, 29, 31, 32) showed the differences of the relative incidences of physeal injuries through the distal radius and the distal tibia to be larger with a dominance of injuries through the distal radius. This might be because non-displaced physeal fractures were excluded from the material by Alffram and Bauer (1), but other factors such as different epidemiology on different places, different selection of materials concerning relative incidencies, and girls more frequently participating in sports than earlier might also be of importance. Finally, the diagnosis of non-displaced physeal fractures can show difficulties (7, 14, 22).

In conclusion the incidence of longitudinal tibio-fibular shaft fractures showed the highest value in the lower ages, whereas ankle fractures of rotational type showed the highest incidence in the older child. Transverse tibio-fibular shaft fractures also showed a decreasing frequency in girls but not in boys due to a larger frequency of injuries mainly because of traffic and soccer accidents. Ankle fractures caused by bending showed a more even incidence compared with ankle fractures due to rotational trauma as did transverse tibio-fibular shaft fractures, especially in girls, compared with longitudinal. Thus, the concept of ankle fractures in children includes not only information about incidence, genetic production, fracture mechanism, growth plate and joint injury, treatment, and prognosis, but also associated with or alternative injuries such as fractures of the tibio-fibular shaft.

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